Major Article

Active surveillance for acute respiratory infections among pediatric long-term care facility staff

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Background: Transmission of respiratory viruses between staff and residents of pediatric long-term care facilities (pLTCFs) can occur. We assessed the feasibility of using text or email messages to perform surveillance for acute respiratory infections (ARIs) among staff.
Methods: From December 7, 2016 to May 7, 2017, 50 staff participants from 2 pLTCFs received weekly text or email requests to report the presence or absence of ARI symptoms. Those who fulfilled the ARI case definition (≥2 symptoms) had respiratory specimens collected to detect viruses by reverse transcriptase polymerase chain reaction assays. Pre- and postsurveillance respiratory specimens were collected to assess subclinical viral shedding.
Results: The response rate to weekly electronic messages was 93%. Twenty-one ARIs reported from 20 (40%) participants fulfilled the case definition. Respiratory viruses were detected in 29% (5/17) of specimens collected at symptom onset (influenza B, respiratory syncytial virus, coronavirus [CoV] 229E, rhinovirus [RV], and dual detection of CoV OC43 and bocavirus). Four participants had positive presurveillance (4 RV), and 6 had positive postsurveillance specimens (3 RV, 2 CoV NL63, and 1 adenovirus).
Conclusions: Electronic messaging to conduct ARI surveillance among pLTCF staff was feasible.
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INTRODUCTION

Residential pediatric long-term care facilities (pLTCF) care for medically fragile children with complex comorbid conditions. Acute respiratory infections (ARIs) are the most common healthcare-associated infections among pLTCF residents and are associated with increased morbidity, cost, and acute care hospitalizations.[1] In both acute care and nursing homes caring for adults, transmission of respiratory viruses from healthcare workers to patients has been described.[2,3] However, little is known about the burden of ARIs and respiratory viruses among staff in pLTCFs.

In this pilot study, we assessed the feasibility of using weekly electronic reminders to perform ARI surveillance among pLTCF staff who routinely had direct resident contact. Measures of feasibility included the frequency of staff responses to electronic reminders over time; the proportion of self-reported ARIs that fulfilled the study case definition; and ability to collect illness onset and 4 weeks of follow-up swabs from those with confirmed ARIs to detect respiratory viruses and determine the duration of viral shedding.

METHODS

Study design, sites, and participants

From December 7, 2016 to May 7, 2017, we performed a prospective surveillance study for ARIs among staff at 2 free-standing pLTCFs in the New York metropolitan area serving residents ≤21 years of age. In 2013, New York State instituted a public health mandate requiring unvaccinated staff to wear face masks during the influenza season in areas where residents are typically present.[4] At site A (137 beds), influenza vaccination for staff was mandated and at site B (97 beds) it was strongly encouraged; during the 2016-2017 influenza season, 100% of staff at both sites were vaccinated. While both facilities had policies addressing diagnostic evaluation of residents with ARIs, neither site routinely performed viral diagnostic testing for staff with ARIs.

We set a recruitment target of 50 participants who received $50 in gift cards ($25 at enrollment and $25 at study end). Eligible staff members (N = 735) were those with routine direct contact with residents, including nurses, physicians, and therapists. Ineligible staff included food service workers, social workers, teachers, housekeepers, and subspecialty consultants. Staff were recruited by a flyer, an information sheet, and face-to-face discussions with the research coordinator (RC). This study was approved by the Columbia University Irving Medical Center institutional review board, and the Centers for Disease Control and Prevention formally relied on their review. Participants provided written informed consent.

Surveillance for ARIs

The ARI case definition used in this study was 2 or more of the following within the prior week: self-reported fever or feeling feverish, runny nose or nasal congestion, chills, shortness of breath, wheezing, new or different cough, new or different sputum, sore or scratchy throat, headache, and/or myalgia. Throughout the 21-week surveillance period, the RC sent weekly text or email messages, per participant preference, to remind them to report whether or not they were experiencing any ARI symptoms. The RC contacted participants responding "Yes" to the message to review their symptoms and confirm that participants fulfilled the ARI study case definition. Staff did not receive electronic messages during their vacation or while on extended medical leave.

Specimen collection and virology testing

During the surveillance period, participants with ARIs meeting the case definition had specimens obtained within 4 days of symptom onset and weekly for 4 weeks thereafter to assess the duration of viral detection. When acceptable to participants, both mid-turbinate and throat specimens were collected to maximize the yield of viral detection using flocked swabs (Copan Diagnostics Inc., Murrieta, CA) which were placed in the same vial of viral transport media. However, if only 1 swab was collected, the type of specimen, ie, mid-turbinate vs throat was also noted. Specimens could be collected by the RC or by the participants themselves, if swabbing by the RC was not feasible, eg, staff absenteeism due to illness. Participants were shown how to complete mid-turbinate self-swab by the RC, were provided a diagram of the mid-turbinate region, verbally confirmed understanding the process, and were given a kit containing the swab, transport media and a biohazard bag. Instructions for obtaining throat swabs were not provided. Within the 4 weeks before and after the surveillance period, the RC also obtained specimens from participants to assess subclinical viral detection. Specimens were aliquoted and stored at −70°C in the research laboratory at Columbia University Irving Medical Center. De-identified specimens were then shipped to the Centers for Disease Control and Prevention laboratory for processing.

Total nucleic acid was extracted from 300 μL of combined nasal and throat specimens and eluted in a final volume of 100 μL using the NucliSENS easyMAG (bioMérieux).[5] Viral testing was performed using a commercial multiplex real-time RT-PCR (rRT-PCR) assay kit, RTD Respiratory Pathogens 21 cat#FTD-2-64 (Fast-track Diagnostics, Luxembourg) as per the manufacturer's protocol. A test result was considered to be positive when threshold cycle (Ct) values were ≤40. Both positive and negative controls were included in all runs to monitor assay performance. Since cross-reactions may occur between rhinoviruses (RV) and other enteroviruses using rRT-PCR assays, sequencing of partial VP4/VP2 regions was conducted to confirm all of the RV detections and determine the specific RV type.

Data collection and analysis

Participants' occupations were collected at enrollment. The overall response rate was determined, as were the response rate to emails vs text messages and response rate during the first vs second half of the surveillance period using Chi square tests. The proportion of reported ARIs that fulfilled the case definition and days of missed work were calculated. The proportion of specimens collected at illness onset and during 4 weeks of follow-up that were positive for respiratory viruses was determined. Detection of viruses was assessed in ARI episodes with one or more specimens. All statistical analyses were performed in SAS 9.4 (Cary, NC). A P value <.05 was considered statistically significant.

RESULTS

Fifty participants were recruited; 27 participants from Site A and 23 from Site B. About half (54%) were nursing staff, 22% were physicians or nurse practitioners, 6% were respiratory or physical therapists and 14% were music, art, and recreational therapists; 4% had other occupations.

Responses to weekly electronic ARI surveillance messages

The RC sent 890 messages during the surveillance period; most were text messages (n = 702, 79%). Participants were more likely to respond to text (95%, 665/702) than email (87%, 163/188) messages (P < .01). Response rates were the same during weeks 1-10 of surveillance (93%) compared to weeks 11-21 (93%) and between the two sites (both sites 93% P=.704). Response rates among nurses vs other types of staff were similar (94% vs 92%, P = .243).

Collection of pre- and postsurveillance, confirmed ARIs, and ARI follow-up specimens

All participants had pre- and postsurveillance mid-turbinate swabs collected; 100% and 96% had pre- and postsurveillance throat swabs collected, respectively. Twenty-five participants self-reported 31 ARIs (17 from Site A and 14 from Site B); 21 (68%) ARIs in 20 participants fulfilled the case definition. Of the 21 confirmed ARIs, 7 (33%) were associated with missing work (median 2 days [IQR 1-2.5] days). Swabs were obtained at illness onset from 17 (81%) of 21 confirmed ARIs and mid-turbinate swabs were obtained more often than throat swabs (81% vs 29%, P = .002); 12 mid-turbinate specimens were self-swabs (Table 1). During the 4 weeks of follow-up, 87 of 168 (52%) expected mid-turbinate and throat swabs were collected, and mid-turbinate swabs were obtained more often than throat swabs (74% vs 30%, P<.001). All four weeks of follow-up swabs were collected for 10 (48%) subjects with ARIs. No swabs were obtained for 1 subject who reported an ARI.

Table 1
Collection of surveillance swabs from acute respiratory infections fulfilling case definition*

Type of specimens	Total acute respiratory infections (n = 21)	Site A (n = 13)	Site B (n = 8)
Onset mid-turbinate swabs	17 (81%)	10 (77%)	7 (88%)
Onset throat swabs	6 (29%)	2 (15%)	4 (50%)
Follow-up mid-turbinate swabs (any week)	20 (95%)	12 (92%)	8 (100%)
Follow-up throat swabs (any week)	15 (71%)	9 (69%)	6 (75%)
Follow-up mid-turbinate swabs (all 4 weeks)	10 (48%)	6 (46%)	4 (50%)
No follow-up swabs	1 (5%)	1 (8%)	0 (0%)

*Acute respiratory infection was defined as 2 or more of the following: self-reported fever or feeling feverish, runny nose or nasal congestion, chills, shortness of breath, wheezing, new or different cough, new or different sputum, sore or scratchy throat, headache, and/or myalgia.

Virology during ARIs, viral shedding, and pre- and postsurveillance

Overall, 10 (48%) of 21 ARI episodes were associated with a detected virus(es). Viruses were detected from 5 (29%) of the 17 ARIs that had specimens obtained within 4 days of onset of symptoms (Table 2). RV (n = 1, 6%), influenza B (n = 1, 6%), respiratory syncytial virus (n = 1, 6%), Coronavirus (CoV) 229E (n = 1, 6%), and both CoV OC43 and bocavirus (n = 1, 6%) were detected from these specimens. Minimal evidence of shedding was observed; taking into account onset and follow-up specimens available for each ARI, only 2 illnesses had more than 1 detection of the same virus. In ARI episode #12, RV-C16 was detected at onset and week 1 of follow-up. In ARI episode #18, CoV 229E was detected in weeks 2 and 3 and human metapneumovirus was detected in week 4 (Table 2). ARI episodes #7 and #10 occurred in the same participant over 1 month apart; neither episode had a virus detected. Viruses were detected in seven participants with ARIs who did not miss work.

RV (types C4, B72, B6, and B101) was detected in presurveillance specimens from 4 (8%) participants. Six participants (12%) had viruses detected postsurveillance, including 3 with RV (types A65, C33, and A106), 1 with adenovirus, and 2 with CoV NL63. One participant had RV detected both pre- and postsurveillance, but they were different RV types. There was no correlation in viral detections among pre- and postsurveillance specimens and those associated with ARIs.

DISCUSSION

Among 50 staff members with direct resident contact in 2 pLTCFs, active ARI surveillance using electronic messages proved feasible. Participants responded to 93% of the weekly messages, and response rates were sustained during the 21-week study period. Responses to text messages were more frequent than responses to emails. Overall, 68% of self-reported ARIs fulfilled the ARI study case definition. These findings suggest that text messaging could help facilities or public health authorities quickly identify ARIs among healthcare workers, including those that are not medically attended. These may be missed using a medical and administrative record-based approach. Rapid and thorough case ascertainment is particularly important during outbreaks to inform implementation of appropriate infection control measures. However, strategies to confirm ARIs using a validated ARI case definition should be included as staff may misinterpret their symptoms as ARIs.

Pre- and postsurveillance specimens were collected from almost every participant, and swabs were collected within 4 days of illness onset from 81% of ARIs. Up to 4 weekly follow-up specimens were also collected for each ARI to assess duration of viral shedding and potential contagiousness, but few repeat viral detections were observed. However, the collection of follow-up specimens was suboptimal, as only 74% of expected follow-up specimens were obtained

Table 2
Results of onset swabs and follow-up swabs from 21 acute respiratory illnesses in 20 pediatric long-term care facility staff*

ARI episode	Onset date	Onset specimen Self vs RC	Week 1	Week 2	Week 3	Week 4
Site A						
1	12/16/2016	NEG-self	ND	NEG	NEG	**RV-A76**
2	12/24/2016	ND	NEG	NEG	NEG	NEG
3	12/31/2016	ND	NEG	ND	NEG	ND
4	1/2/2017	NEG-self	NEG	**BoV**	NEG	NEG
5	1/7/2017	NEG-self	**PIV4**	NEG	NEG	NEG
6	1/11/2017	**CoV OC43 & BoV-self**	ND	NEG	NEG	ND
7†	1/22/2017	NEG-self	ND	ND	ND	NEG
8	2/6/2017	ND	ND	ND	ND	ND
9	2/13/2017	**FluB-self**	ND	NEG	NEG	NEG
10†	2/27/2017	NEG-RC	ND	NEG	ND	NEG
11	2/28/2017	NEG-self	NEG	NEG	NEG	NEG
12	3/9/2017	**RV-C16-self**	**RV-C16**	NEG	NEG	NEG
13	4/20/2017	NEG-self	NEG	NEG	NEG	NEG
Site B						
14	12/9/2016	ND	**HMPV**	NEG	NEG	ND
15	12/18/2016	**RSV-RC**	NEG	ND	NEG	ND
16	1/2/2017	NEG-RC	NEG	NEG	ND	ND
17	1/19/2017	**CoV 229E-self**	NEG	NEG	NEG	NEG
18	2/14/2017	NEG-self	NEG	**CoV 229E**	**CoV 229E**	**HMPV**
19	2/15/2017	NEG-RC	NEG	NEG	NEG	NEG
20	4/20/2017	NEG-self	NEG	NEG	NEG	NEG
21	4/21/2017	NEG-RC	NEG	NEG	ND	ND

Abbreviations: ARI = acute respiratory illness; BoV = bocavirus; CoV = coronavirus; Flu = influenza; HMPV = human metapneumovirus; ND = not done; NEG = negative; PIV = parainfluenza virus; RC = research coordinator; RSV = respiratory syncytial virus; RV = rhinovirus.
Positive results are provided in bold.
*Four ARIs did not have an onset specimen obtained.
†Same participant experienced ARI episodes #7and #10.

and mid-turbinate swabs were more often obtained than throat swabs. We speculate that illness-related absenteeism and the complex, irregular work schedules of participants impeded collection of study specimens. The RC also learned that many participants did not find throat swabs tolerable.

A minority of (29%) ARI onset specimens had a virus detected, only one of which was influenza. There may be several reasons for the relatively low rate of viral detection from ARI onset swabs. Many onset swabs were obtained through participant self-swabbing, so it is possible that despite training, swabs were improperly collected, improperly stored, or not obtained in a timely manner. However, we and others have shown that the yield from mid-turbinate self-swabs compares favorably with the yield of swabs obtained by research staff.[6,7] Also, our ARI case definition may have captured nonviral entities such as allergic rhinitis, bacterial sinusitis, and bacterial pharyngitis.

Several different respiratory viruses were detected during the surveillance period, which included the typical months for influenza and respiratory syncytial virus activity, as well as before and after the surveillance period. The infectivity of asymptomatic staff and those with negative PCR assays is unknown. Together these findings suggest that staff may serve as vectors and reservoirs for respiratory viruses, particularly given the frequent and close physical contact between residents and staff during medical care, play, and educational activities.[8] This is of particular concern as young infants and immunocompromised children may reside in pLTCFs. Additionally, we found that two-thirds of participants with ARIs did not miss work (7 had viruses detected). Presenteeism, or working while ill, has been previously described; in a Tennessee children's hospital, 46% of healthcare workers reported working with an influenza-like illness.[9]

There are several limitations to this study. Because the study only involved 2 pLTCFs located in the same geographic area, the results may not be generalizable to other facilities. Participants may not have been representative of staff at the participating sites. The sample size was small and only involved surveillance for a single respiratory virus season. Additionally, control specimens were not collected throughout the surveillance time period from participants without ARI symptoms, which could have further informed interpretation of the viral detections observed. We could not assess the relative yield of self-swabbing vs RC-swabbing nor of throat vs mid-turbinate swabs as these were combined prior to testing. Only half of follow-up specimens were collected which limited assessment of prolonged detection of viruses. Finally, it was not assessed if staff ARIs were linked to resident illnesses.

In conclusion, we found that utilizing weekly electronic messages for ARI surveillance among staff in pLTCFs was feasible, and this effort could inform future surveillance efforts in long-term care facilities. The findings of this study also have relevance for potential control strategies for COVID-19 in LTCFs which have both vulnerable residents and staff. We found that surveillance for symptoms was feasible and that staff could perform self-swabs which could reduce the risk to other staff members. The potential for staff with ARIs or minimal or absent symptoms to harbor respiratory viruses highlights the importance of staff education to prevent introduction and spread of respiratory viruses to frail and medically complex pLTCF residents. Potential educational strategies could include improving hand hygiene, adherence to droplet precautions for ill residents, as well as avoiding presenteeism. Future studies comparing ARI surveillance and concomitant viral testing results of staff and residents would be useful to assess potential transmission patterns.

Acknowledgments

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